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Light-Duty Automotive Technology and Fuel Economy Trends: 1975 Through 2005

Appendix C: City and Highway Driving Data

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Appendix C

City/Highway Driving

Inherent in the "Combined" or "55/45" mpg calculation is the apportionment of the miles into those for which the "city" mpg number is an appropriate measure and those for which the "highway" mpg number is also appropriate.

If the travel of a vehicle or a group of vehicles can be divided into, say, two modes of travel, then the mpg for that total travel can be calculated as:

$$MPG_{AVE} = \frac{\text{Total Miles}}{\text{Total Gallons}}$$

If the two modes of travel are urban (represented by the city mpg) and non-urban (represented by the highway mpg), then

$$MPG_{AVE} = \frac{\text{Urban Miles + Non-Urban Miles}}{\text{Urban Gallons + Non-Urban Gallons}}$$

Noting that $\text{gallons} = \frac{\text{Miles}}{\text{MPG}}$

$$MPG_{AVE} = \frac{\text{Urban Miles + Non-Urban Miles}}{\frac{\text{Urban Miles}}{\text{City MPG}} + \frac{\text{Non-Urban Miles}}{\text{Highway MPG}}}$$

and since city fraction is defined as urban miles/total miles, if we divide top and bottom by total miles (which equals urban miles plus non-urban miles), we get

$$MPG_{AVE} = \frac{1}{\frac{\text{City Fraction}}{\text{City MPG}} + \frac{\text{Highway Fraction}}{\text{Highway MPG}}}$$

Looking at just city fraction (CF), since highway fraction = 1-CF, and the value for city fraction, we obtain

$$MPG_{AVE} = \frac{1}{\frac{\text{City Fraction}}{\text{City MPG}} + \frac{\text{1-CF}}{\text{Highway MPG}}}$$

For the case where CF = 0.55, we get the "55/45" mpg definition, namely,

$$MPG_{55/45} = \frac{1}{\frac{0.55}{\text{City MPG}} + \frac{0.45}{\text{Highway MPG}}}$$

When the combined mpg value was first introduced in the early 1970s, the appropriate value was 55 percent for the city fraction and 45 percent for the highway fraction. Even though these values have been institutionalized, for example, in the fuel economy standards, they were changing. They were changing before the 1970s and continue to change. The values, obtained from the Department of Transportation's VM-1 tables, are listed in Table C-1. As shown in Figure C1, the city fraction for both cars and trucks has increased over the years, reflecting the larger growth in urban vehicle miles traveled (VMT). This would be expected to have a larger negative effect on combined mpg since a higher city fraction weights the city mpg more, and the city mpg is almost always lower than the highway mpg.

The city fractions and mpg values used for Figure C2 which shows the effect of CF on average mpg are given in Tables C-2, C-3 and C-4. The values are all derived from the DOT VM-1 tables published yearly by the U.S. Department of Transportation in their publication *Highway Statistics.*

For the calculations for cars, the car vector was used; for trucks, the truck vector was used; and for the "both" calculation, the "both" vector was used. Cars and light trucks may have had different city fractions in the past, but they are essentially the same now.

Figure C-2 shows the trends in adjusted city/highway—weighted mpg versus time for cars, trucks, and cars and trucks combined. For each strata on this figure, one line shows the values as estimated with a constant 55/45 value for the city fraction/ highway fraction; the other line shows the value using the actual city fraction values.

Percent City Driving
1966 to 2002

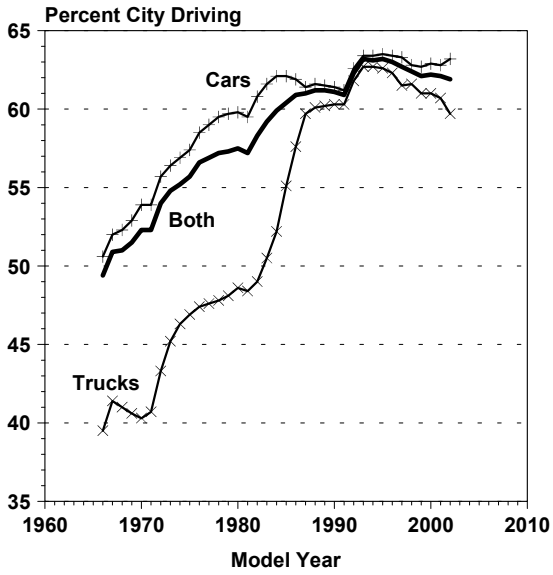

Figure C1

Fuel Economy by Model Year
The Influence of City Driving

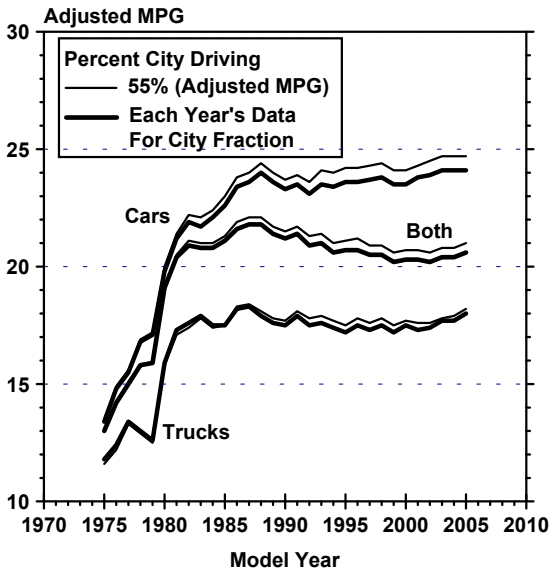

Figure C2

If the adjusted mpg values provide an improved estimate of the mpg likely to be achieved in actual use, then accounting for the increase in city fraction should improve the estimate. In this way, the combined car and light truck laboratory fuel economy value of 24.6 mpg can be adjusted to 21.0 mpg using the 0.90 and 0.78 city and highway fuel economy adjustment factors, and if the change in city fraction is accounted for, a value of 20.6 mpg for the combined model year 2005 new vehicle fleet is obtained (See Table C-3.)

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Table C-1 **City Fraction from 1966 to 2002**

Year	Cars	Trucks	Both Cars and Trucks
1966	50.6	39.5	49.4
1967	52.0	41.4	50.9
1968	52.3	41.0	51.0
1969	52.9	40.6	51.5
1970	53.9	40.3	52.3
1971	53.9	40.7	52.3
1972	55.7	43.3	54.0
1973	56.4	45.2	54.8
1974	56.9	46.3	55.2
1975	57.4	46.9	55.7
1976	58.5	47.4	56.6
1977	59.0	47.6	56.9
1978	59.5	47.8	57.2
1979	59.7	48.1	57.3
1980	59.8	48.6	57.5
1981	59.5	48.4	57.2
1982	60.8	49.0	58.3
1983	61.6	50.5	59.2
1984	62.1	52.2	59.9
1985	62.1	55.1	60.4
1986	61.9	57.6	60.9
1987	61.4	59.7	61.0
1988	61.6	60.1	61.2
1989	61.5	60.2	61.2
1990	61.4	60.3	61.1
1991	61.2	60.3	60.9
1992	62.6	61.8	62.3
1993	63.4	62.7	63.2
1994	63.4	62.7	63.1
1995	63.5	62.6	63.2
1996	63.4	62.3	63.0
1997	63.3	61.5	62.7
1998	62.8	61.6	62.4
1999	62.7	61.0	62.0
2000	62.9	61.0	62.2
2001	62.8	60.7	62.1
2002	63.2	59.7	61.9

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Table C-2 **Adjusted Fuel Economy of 1975 to 2005 Cars**

MODEL YEAR	SALES (000)	FRAC	CITY MPG	HWY MPG	55/45 MPG	PERCENT CITY	REVISED MPG
1975	8237	0.806	12.3	15.2	13.5	57.4%	13.4
1976	9722	0.788	13.7	16.6	14.9	58.5%	14.8
1977	11300	0.800	14.4	17.4	15.6	59.0%	15.5
1978	11175	0.773	15.5	19.1	16.9	59.5%	16.8
1979	10794	0.778	15.9	19.2	17.2	59.7%	17.1
1980	9443	0.835	18.3	22.6	20.0	59.8%	19.8
1981	8733	0.827	19.6	24.2	21.4	59.5%	21.2
1982	7819	0.803	20.1	25.5	22.2	60.8%	21.9
1983	8002	0.777	19.9	25.5	22.1	61.6%	21.7
1984	10675	0.761	20.2	26.0	22.4	62.1%	22.1
1985	10791	0.746	20.7	26.8	23.0	62.1%	22.6
1986	11015	0.717	21.3	27.7	23.8	61.9%	23.4
1987	10731	0.722	21.5	28.0	24.0	61.4%	23.6
1988	10736	0.702	21.8	28.5	24.4	61.6%	24.0
1989	10018	0.693	21.4	28.3	24.0	61.5%	23.6
1990	8810	0.698	21.1	28.1	23.7	61.4%	23.3
1991	8524	0.678	21.2	28.3	23.9	61.2%	23.5
1992	8108	0.666	20.8	28.3	23.6	62.6%	23.1
1993	8456	0.640	21.3	28.8	24.1	63.4%	23.5
1994	8414	0.596	21.1	28.8	24.0	63.4%	23.4
1995	9396	0.620	21.2	29.3	24.2	63.5%	23.6
1996	7890	0.600	21.2	29.3	24.2	63.4%	23.6
1997	8335	0.576	21.3	29.4	24.3	63.3%	23.7
1998	7971	0.551	21.3	29.6	24.4	62.8%	23.8
1999	8379	0.551	21.1	29.2	24.1	62.7%	23.5
2000	9128	0.551	21.1	29.1	24.1	62.9%	23.5
2001	8408	0.539	21.4	29.3	24.3	62.8%	23.8
2002	8305	0.515	21.6	29.3	24.5	63.2%	23.9
2003	7952	0.504	21.8	29.7	24.7	63.2%	24.1
2004	8147	0.512	21.7	29.8	24.7	63.2%	24.1
2005	8616	0.502	21.8	29.7	24.7	63.2%	24.1

Table C-3 **Adjusted Fuel Economy of 1975 to 2005 Trucks**

MODEL YEAR	SALES (000)	FRAC	CITY MPG	HWY MPG	55/45 MPG	PERCENT CITY	REVISED MPG
1975	1987	0.194	10.9	12.7	11.6	46.9%	11.8
1976	2612	0.212	11.5	13.2	12.2	47.4%	12.4
1977	2823	0.200	12.6	14.1	13.3	47.6%	13.4
1978	3273	0.227	12.4	13.7	12.9	47.8%	13.0
1979	3088	0.222	12.1	13.1	12.5	48.1%	12.6
1980	1863	0.165	14.8	17.1	15.8	48.6%	15.9
1981	1821	0.173	16.0	18.6	17.1	48.4%	17.3
1982	1914	0.197	16.3	19.0	17.4	49.0%	17.6
1983	2300	0.223	16.5	19.6	17.8	50.5%	17.9
1984	3345	0.239	16.1	19.3	17.4	52.2%	17.5
1985	3669	0.254	16.2	19.4	17.5	55.1%	17.5
1986	4350	0.283	16.9	20.2	18.3	57.6%	18.2
1987	4134	0.278	16.9	20.7	18.4	59.7%	18.3
1988	4559	0.298	16.5	20.4	18.1	60.1%	17.9
1989	4435	0.307	16.3	20.1	17.8	60.2%	17.6
1990	3805	0.302	16.1	20.2	17.7	60.3%	17.5
1991	4049	0.322	16.4	20.7	18.1	60.3%	17.9
1992	4064	0.334	16.1	20.4	17.8	61.8%	17.5
1993	4754	0.360	16.1	20.7	17.9	62.7%	17.6
1994	5710	0.404	16.0	20.3	17.7	62.7%	17.4
1995	5749	0.380	15.8	20.2	17.5	62.6%	17.2
1996	5254	0.400	16.0	20.7	17.8	62.3%	17.5
1997	6124	0.424	15.8	20.4	17.6	61.5%	17.3
1998	6485	0.449	16.0	20.8	17.8	61.6%	17.5
1999	6839	0.449	15.7	20.3	17.5	61.0%	17.2
2000	7447	0.449	16.0	20.5	17.7	61.0%	17.5
2001	7202	0.461	15.9	20.2	17.6	60.7%	17.3
2002	7815	0.485	15.8	20.3	17.6	59.7%	17.4
2003	7824	0.496	16.0	20.7	17.8	58.7%	17.7
2004	7772	0.488	16.0	20.8	17.9	59.7%	17.7
2005	8534	0.498	16.3	21.3	18.2	59.7%	18.0

Table C-4 **Adjusted Fuel Economy of 1975 to 2005 Both**

MODEL YEAR	SALES (000)	FRAC	CITY MPG	HWY MPG	55/45 MPG	PERCENT CITY	REVISED MPG
1975	10224	1.000	12.0	14.6	13.1	55.7%	13.0
1976	12334	1.000	13.2	15.7	14.2	56.6%	14.2
1977	14123	1.000	14.0	16.6	15.1	56.9%	15.0
1978	14448	1.000	14.7	17.5	15.8	57.2%	15.8
1979	13882	1.000	14.9	17.4	15.9	57.3%	15.9
1980	11306	1.000	17.6	21.5	19.2	57.5%	19.1
1981	10554	1.000	18.8	23.0	20.5	57.2%	20.4
1982	9732	1.000	19.2	23.9	21.1	58.3%	20.9
1983	10302	1.000	19.0	23.9	21.0	59.2%	20.8
1984	14020	1.000	19.1	24.0	21.0	59.9%	20.8
1985	14460	1.000	19.3	24.4	21.3	60.4%	21.1
1986	15365	1.000	19.9	25.1	21.9	60.9%	21.6
1987	14865	1.000	20.0	25.5	22.1	61.0%	21.8
1988	15295	1.000	19.9	25.5	22.1	61.2%	21.8
1989	14453	1.000	19.5	25.2	21.7	61.2%	21.4
1990	12615	1.000	19.3	25.1	21.5	61.1%	21.2
1991	12573	1.000	19.4	25.3	21.7	60.9%	21.4
1992	12172	1.000	18.9	25.0	21.3	62.3%	20.9
1993	13211	1.000	19.1	25.2	21.4	63.2%	21.0
1994	14125	1.000	18.7	24.7	21.0	63.1%	20.5
1995	15145	1.000	18.8	25.0	21.1	63.2%	20.7
1996	13144	1.000	18.7	25.1	21.2	63.0%	20.7
1997	14459	1.000	18.6	24.8	20.9	62.7%	20.5
1998	14457	1.000	18.5	24.9	20.9	62.4%	20.5
1999	15218	1.000	18.3	24.4	20.6	62.1%	20.2
2000	16574	1.000	18.4	24.5	20.7	62.2%	20.3
2001	15610	1.000	18.4	24.3	20.7	62.1%	20.3
2002	16120	1.000	18.3	24.1	20.6	61.9%	20.2
2003	15776	1.000	18.5	24.4	20.8	61.9%	20.4
2004	15920	1.000	18.5	24.6	20.8	61.9%	20.4
2005	17150	1.000	18.6	24.8	21.0	61.9%	20.6

Appendix C

Considering the trends in the fuel economy of cars, light trucks, and the combined fleet, it is usually the case that the combined 55/45 mpg value is considered. In addition to the city fraction, the relationship between the highway and the city fuel economy influences the result of the calculation. Figures C3 and C4 compare the trend in the ratio of laboratory highway to city fuel economy, and each year's values for laboratory highway, combined 55/45, and city fuel economy for conventionally powered cars and trucks. The overall influence since 1975 has tended toward a higher value for the highway to city fuel economy ratio since the highway fuel economy values have generally increased at faster rate than city fuel economy.

Laboratory Fuel Economy
Cars with Conventional Powertrains

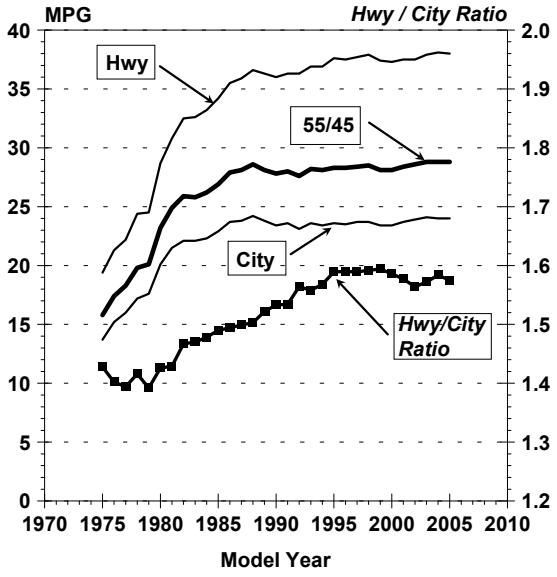

Figure C3

Laboratory Fuel Economy
Trucks with Conventional Powertrains

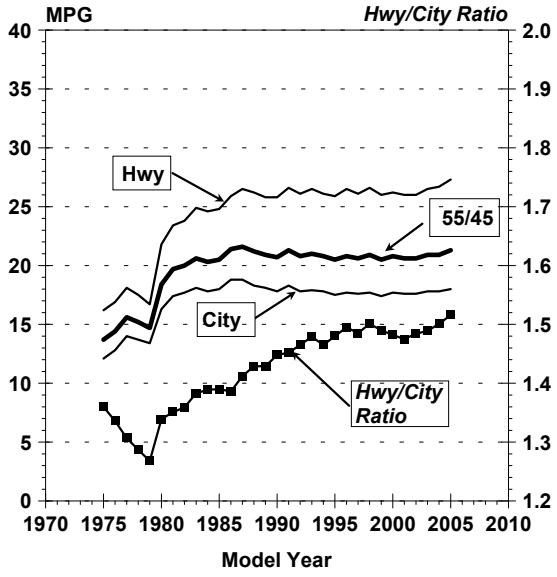

Figure C4